

## Declarative Programming

### Workshop exercises set 3.

#### QUESTION 1

If you were working on a program that functioned as a web server, and thus its output was in the form of web pages, you could:

- (a) have the program write out each part of the page as soon as it has decided what it should be;
- (b) have the program generate the output in the form of a string, and then print the string;
- (c) have the program generate the output in the form of a representation such as the HTML type of the previous questions, and then convert that to a string and then print the string.

Which of these approaches would you choose, and why?

#### QUESTION 2

Implement a function `ftoc :: Double -> Double`, which converts a temperature in Fahrenheit to Celsius. Recall that  $C = (5/9) * (F - 32)$ . What is the inferred type of the function if you comment out the type declaration? What does this tell you?

#### QUESTION 3

Implement a function `quadRoots :: Double -> Double -> Double -> [Double]`, which computes the roots of the quadratic equation defined by  $0 = a*x^2 + b*x + c$ , given  $a$ ,  $b$ , and  $c$ . See [http://en.wikipedia.org/wiki/Quadratic\\_formula](http://en.wikipedia.org/wiki/Quadratic_formula) for the formula. What is the inferred type of the function if you comment out the type declaration? What does this tell you?

#### QUESTION 4

Write a Haskell function to merge two sorted lists into a single sorted list

#### QUESTION 5

Write a Haskell version of the classic quicksort algorithm for lists. (Note that while quicksort is a good algorithm for sorting arrays, it is not actually that good an algorithm for sorting lists; variations of merge sort generally perform better. However, that fact has no bearing on this exercise.)

#### QUESTION 6

Given the following type definition for binary search trees from lectures,

```
>data Tree k v = Leaf | Node k v (Tree k v) (Tree k v)
>    deriving (Eq, Show)
```

define a function

```
>same_shape :: Tree a b -> Tree c d -> Bool
```

which returns `True` if the two trees have the same shape: same arrangement of nodes and leaves, but possibly different keys and values in the nodes.

#### QUESTION 7

Consider the following type definitions, which allow us to represent expressions containing integers, variables "a" and "b", and operators

for addition, subtraction, multiplication and division.

```
>data Expression
>    = Var Variable
>    | Num Integer
>    | Plus Expression Expression
>    | Minus Expression Expression
>    | Times Expression Expression
>    | Div Expression Expression
```

```
>data Variable = A | B
```

For example, we can define `exp1` to be a representation of  $2*a + b$  as follows:

```
>exp1 = Plus (Times (Num 2) (Var A)) (Var B)
```

Write a function `eval :: Integer -> Integer -> Expression -> Integer` which takes the values of `a` and `b` and an expression, and returns the value of the expression. For example `eval 3 4 exp1 = 10`.